UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2011/2012

January 2012

EBS 209/3 - Mineralogy
[Mineralogi]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TEN printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of SEVEN questions. TWO questions in PART A and FIVE questions in PART B.
[Kertas soalan ini mengandungi TUJUH soalan. DUA soalan di BAHAGIAN A dan LIMA soalan di BAHAGIAN B.]

Instruction: Answer **FIVE** questions. Answer **ALL** questions from PART A and **THREE** questions from PART B. If a candidate answers more than five questions only the first five questions answered in the answer script would be examined.
*[**Arahan**: Jawab **LIMA** soalan. Jawab **SEMUA** soalan dari BAHAGIAN A dan **TIGA** soalan dari BAHAGIAN B. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

The answers to all questions must start on a new page.
[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

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PART A / *BAHAGIAN A*

Answer all of the following questions (Questions 1 and 2).

Jawab semua soalan yang berikut (Soalan 1 dan 2).

1. Answer all the following questions.
Jawab semua soalan-soalan berikut.

(a) What is crystal form? Illustrates the model pattern for the following crystal forms:

Apakah itu bentuk kristal? Gambarkan corak model bagi bentuk-bentuk kristal berikut:

(i) Trigonal prism / *Trigonal prisma*

(ii) Octahedron / *Oktahedron*

(iii) Tetragonal prism / *Tetragonal prisma*

(b) What is the minimum potential in kV that is required to excite Cu K-series radiation from a Cu-target X-ray tube? Absorption edge of Cu = 1.380Å. Forsterite (Mg_2SiO_4) is an orthorhombic with perimeters a = 4.75; b = 10.20; c = 5.98Å. Given atomic weight of Mg = 24, Si = 28 and O = 16. Formula units Z = 4 and Avogadro's number is = 6.023×10^{23}, calculate and determine the following:

Apakah nilai minimum keupayan dalam kV yang diperlukan bagi menguja radiasi Cu K-siri daripada tiub sinar-x dengan sasaran-Cu? Sisian penyerapan bagi kuprum = 1.380Å. Fosterit (Mg_2SiO_4) adalah mineral bersistem ortorombik dengan sisian a = 4.75; b = 10.20; c = 5.98Å. Diberi berat atom bagi Mg = 24, Si = 28 dan O = 16. Unit formula Z = 4 dan Nombor Avogadro = 6.023×10^{23}. Kira dan tentukan perkara-perkara berikut:

(i) 2θ angle for the (201) lattice spacing for Cu-kα (λ = 1.5405Å).
sudut 2θ bagi ruang satah kekisi (201) dengan Cu-kα (λ = 1.5405Å).

(ii) the volume of forsterite in cm^3
isipadu fosterit dalam cm^3

(iii) the molecular weight of forsterite in grams (g)
berat molekul fosterit dalam gram (g)

(iv) the density of forsterite in g/cm^3
ketumpatan fosterit dalam g/cm^3

(v) the specific gravity of forsterite
graviti tentu fosterit

(20 marks/*markah*)

2. Answer all the following questions.
Jawab semua soalan-soalan berikut.

(a) If a face of a form on an orthorhombic crystal intercept axis a at 33.96Å, the b axis at 44.6Å, and c axis at 15.41Å (all measured from the axes intersection or vortex), calculate:
(i) The parameters of the face
(ii) The Miller Indices
GIVEN: the unit cell dimensions:

a = 11.32Å b = 22.30Å c = 30.82Å

Sekiranya suatu muka bagi satu hablur ortorombik menyilang pada paksi a pada 33.96 Å, 44.6Å pada paksi b, dan 15.41Å pada paksi c (semuanya diukur dari titik persilangan atau vorteks), kirakan:
(i) Parameter-parameter bagi muka itu
(ii) Indeks Miller
DIBERIKAN: dimensi unit sel

a = 11.32Å b = 22.30Å c = 30.82Å

(b) Calculate the formula for the mineral which has the following weight % composition:

$$Ag^{+1} = 65.4\% \quad S^{-2} = 19.4\% \quad As^{+3} = 15.2\%$$

Kirakan formula bagi mineral yang mempunyai peratus berat komposisi seperti berikut:

$$Ag^{+1} = 65.4\% \quad S^{-2} = 19.4\% \quad As^{+3} = 15.2\%$$

(c) Both Mohr's hardness scale and Tenacity are the physical properties of minerals which relatively describe the physical strength and behavior when subjected to force. Please elaborate such properties and how they are classified?

Kedua-dua skala kekerasan Mohr dan "kebolehtempaan" adalah jenis sifat-sifat fizikal mineral yang secara relatifnya menerangkan kekuatan dan kelakuannya apabila dikenakan daya. Sila jelaskan sifat-sifat berkenaan dan bagaimana ianya diklasifikasikan?

(20 marks/*markah*)

PART B / *BAHAGIAN B*

Answer any three (3) questions from this Part (B).

Jawab mana-mana tiga (3) soalan daripada Bahagian (B).

3. Answer the following questions.
Jawab semua soalan-soalan berikut.

(a) The formula of pyrhotite is written $Fe_{1-n}S$. Evaluate n in the following analysis:

Formula kimia pirhotit adalah $Fe_{1-n}S$. Pertimbangkan n dalam analisis berikut:

Element *Elemen*	Fe	Co	Ni	S	Insoluble *Tak larut*
Weight % *Berat %*	57.49	1.50	4.30	35.71	0.33

Also determine the formula and identify the minerals represented by the following analysis (weight percentage).

Tentukan juga formula dan kenalpasti mineral yang diwakili oleh keputusan analisis kimia berikut.

Cu: 63.3%; Fe: 11.1%; S: 25.6%

(b) Given the following mineral formulas, determine the valence (charge and number) of the element labeled "X" in each formula below.

Bagi formula-formula kimia mineral-mineral berikut, tentukan valensi (cas dan nombor) bagi elemen yang dilabelkan "X".

(i) $Al_6XPO_4(OH)_8.2H_2O$ Given: P = +5 */ Diberi: P = +5*

(ii) $X_3Al_2Si_6O_{18}$

(iii) $KAlX_3O_8$

(iv) $Mg_3X_2Si_3O_{12}$

(c) Given the following unit cell dimensions in Å (Angstroms), calculate the axial ratios for each of the two minerals (i), and (ii).

(i) a = 5.0, b = 8.1, c = 14.3 (ii) a = 7.0, b = 4.3, c = 23.1

Berikut diberikan dimensi sel unit (Angstroms, Å), kirakan nisbah paksi bagi kedua-dua mineral berikut (i) dan (ii).

(i) a = 5.0, b = 8.1, c = 14.3 (ii) a = 7.0, b = 4.3, c = 23.1

(20 marks/*markah*)

4. Answer the following questions.

Jawab semua soalan-soalan berikut.

(a) Magnetic minerals result from properties that are specific to a number of elements. State and describe main types of magnetism, and its relation to the presence of such elements, and what is the measuring unit?

Mineral magnetik berpunca daripada sifat sebilangan elemen/unsur tertentu. Nyata dan terangkan jenis-jenis kemagnetan, dan hubungkaitnya dengan kehadiran unsur-unsur tertentu itu, dan apakah unit pengukurannya?

(b) Explain how the specific gravity of an aggregate can be measured with a pycnometer. Calculate the density of ferberite ($FeWO_4$), which is monoclinic with.

a = 4.73; b = 5.70; c = 4.95; β = 90.01; Z = 2,

where the V = abc sin β (Monoclinic)

Avogadro's number (# atoms / mole) = 6.02×10^{23}.

Kirakan ketumpatan mineral ferberit ($FeWO_4$), bersistem monoklinik dengan paksi-paksi

a = 4.73; b = 5.70; c = 4.95; β = 90.01; Z = 2,

yang mempunyai V = abc sin β (Monoklinik),

Nombor Avogadro (# atom/mol) = 6.02×10^{23}

(c) Sketch and illustrate the possible polymerization structures (the silicate class) of the SiO_4 tetrahedra for the following silicate minerals:

(i) Feldspar ($NaAlSi_3O_8$)

(ii) Olivin $(Mg,Fe)_2SiO_4$

(iii) Quartz (SiO_2)

Lakar dan ilustrasikan struktur polimerisasi (kelas silikat) tetrahedral SiO_4 yang mungkin bagi mineral-mineral silikat berikut:

(i) Feldspar ($NaAlSi_3O_8$)

(ii) Olivin $(Mg,Fe)_2SiO_4$

(iii) Quartz (SiO_2)

(20 marks/*markah*)

5. Answer the following questions.
Jawab semua soalan-soalan berikut.

(a) List three (3) distinguishing physical properties that will enable you to differentiate between the following pairs of minerals. State the value of the property to support your argument, eg. diamond (H = 10) has higher Mohr's hardness than talc (H = 1).

Senarai tiga (3) sifat fizikal ungul yang membolehkan anda membezakan pasangan-pasangan mineral berikut. Nyatakan nilai-nilai sifat berkenaan dalam menyokong jawapan anda, contoh intan (H = 10) mempunyai kekerasan Mohr lebih tinggi berbanding talkum (H = 1).

(i) Muscovite from quartz / *Muskovit berbanding kuarza*

(ii) Cassiterite from zircon / *Kasiterit berbanding zirkon*

(iii) Chalcopyrite from galena / *Kalkopirit berbanding galena*

(iii) Hornblende from augite / *Honblend berbanding kuarza*

(iv) Gold from pyrite / *Emas berbanding pirit*

(b) Using the Berzelian scheme, minerals can be classified into silicates and non-silicates based on broad anionic/polyanionic groups.

(i) Discuss the various mineral classes in the non-silicate group with examples.

(ii) Explain the sub-classes within the silicate groups based on their structures with suitable examples.

Dengan mengguna skema Berzelian, mineral boleh diklasifikasikan kepada silikat dan bukan silikat berasaskan kepada pelbagai kumpulan gabungan anion/polianion.

(i) Bincangkan pelbagai kelas mineral bagi kumpulan bukan-silikat

(ii) Jelaskan jenis-jenis sub-kelas dalam kumpulan silikat berasaskan strukturnya beserta contoh-contoh bersesuaian.

[c] Explain each of the following concepts used in mineralogy and provide appropriate examples to illustrate.

Jelaskan konsep-konsep berikut yang digunakan dalam mineralogi dengan contoh-contoh bersesuaian untuk menggambarkannya.

(i) Polymorphism / *Polimorfisma*

(ii) Specific Gravity / *Graviti tentu*

(iii) Isomorphism / *Isomorfisma*

(iv) Hardness / *Kekerasan*

(20 marks/*markah*)

6. Answer the following questions.
Jawab kesemua soalan-soalan berikut.

(a) Crystals, and therefore minerals, have an ordered internal arrangement of atoms into three dimensional frameworks which show symmetrical pattern. State and discuss types of symmetry operations and elements that use imaginatively to classify mineral crystal into 32 classes.

Kristal, justeru mineral, mempunyai susunatur dalaman atom-atom dalam kerangka tiga dimensi teratur yang mempamerkan corak kesemetrian. Nyata dan bincangkan jenis-jenis operasi dan unsur-unsur simetri yang membawa kepada pengelasan hablur mineral kepada 32 kelas.

(b) The common sulfide mineral pyrite (FeS_2) has a density of 5.02 g/cm^3 and a unit cell edge of 5.42 Å. Calculate Z, the number of formula units per cell.

Mineral sulfida (FeS_2) lazimnya mempunyai ketumpatan 5.02 g/cm^3 dengan unit sisian 5.42 Å. Kirakan Z, nombor unit formula per sel.

(c) Chemical compositional variation (referred to Solid solution) occurs as a result of ions substituting for one another in a crystal structure. State and briefly explain the factors that control the amount of solid solution that can be replaced/substituted in given crystal structures. A pyroxene is a solid solution of 40% jadeite ($NaAlSi_2O_6$) and 60% acmite ($NaFeSi_2O_6$). Calculate the weight percent oxides.

Pelbagaian komposisi kimia (dirujuk sebagai larutan pepejal) terjadi akibat penggantian antara satu sama lain ion-ion dalaman struktur hablur. Nyata dan jelaskan faktor-faktor yang mengawal amaun penggantian larutan pepejal dalam struktur hablur tertentu. Piroksin adalah mineral dengan kadar kandungan larutan pepejal 40% jadit ($NaAlSi_2O_6$) dan 60% acmite ($NaFeSi_2O_6$). Kirakan peratus berat oksidanya.

(20 marks/*markah*)

7. Answer the following questions.
Jawab kesemua soalan-soalan berikut.

(a) Color and streak often used to identify (diagnostic property) and to describe physical appearance of mineral. Define and describe these properties in terms of reliability and types.

Warna dan corekan kerapkali digunakan dalam pengecaman (sifat diagnos) dan menerangkan sifat fizikal luaran mineral. Takrif dan jelaskan sifat-sifat ini dari segi kebolehpercayaan dan jenis-jenisnya.

(b) For the given chemical formulas of the following non-silicate and silicate minerals, determine accordingly the appropriate class, group, subclass and their names based on Brezilian classification system.

Bagi formula kimia mineral-mineral silikat dan bukan silikat berikut tentukan kelas, kumpulan, sub-kelas dan nama yang sepatutnya berdasarkan kepada sistem Brezilian.

(i) Mg_2SiO_4
(ii) $CaSO_4.2H_2O$
(iii) $CaMg(CO_3)_2$
(iv) Fe_3O_4
(v) $CuFeS_2$
(vi) $(Na,K)AlSi_3O_8$

(c) Using the general silicate formula, $X_mY_n(Z_pO_q)w_r$, match each appropriate element or element grouping and subscript in each mineral formula below with that of each letter or number in the general formula.

Menggunakan formula umum silikat $X_mY_n(Z_pO_q)w_r$, padankan setiap elemen atau kumpulan elemen dan subskrip dalam setiap mineral di bawah dengan setiap huruf atau nombor ke dalam formula umum tersebut.

(i) $Be_3Al_2Si_6O_{18}$
(ii) $Al_2Si_2O_5(OH)_4$
(iii) $CaAl_2Si_2O_7(OH)_2$
(iv) $Mg_2Si_2O_6$

(20 marks/*markah*)

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